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$$\therefore \frac{A}{4}=\int_0^a\int_0^{\sqrt{(r^2-ax)}}\left[1+\left(\frac{a-2x}{2y}\right)^2\right]^{\frac{1}{2}}dzdx=\int_0^a\int_0^{\sqrt{(r^2-ax)}}\frac{a}{2\sqrt{(ax-x^2)}}dzdx,$$

since $y^2=ax-x^2$.

$$\therefore A=2a\int_0^a\sqrt{\left(\frac{r^2-ax}{ax-x^2}\right)}dx.$$ Putting $x=a\sin^2\phi$,

$$A=2a\int_0^{\frac{1}{2}\pi}\frac{\sqrt{(r^2-a^2\sin^2\phi)}}{\sqrt{(a^3\sin^2\phi-a^2\sin^4\phi)}}.2a\sin\phi\cos\phi\,d\phi$$

$$=4a\int_0^{\frac{1}{2}\pi}\sqrt{(r^2-a^2\sin^2\phi)}.\frac{a\sin\phi\cos\phi}{a\sin\phi\sqrt{(1-\sin^2\phi)}}d\phi$$

$$=4ar\int_0^{\frac{1}{2}\pi}\sqrt{\left(1-\frac{a^2}{r^2}\sin^2\phi\right)}d\phi=4ar\,E\left(\frac{a}{r},\frac{\pi}{2}\right),\ a<r.$$

Also solved by Francis Rust and J. Scheffer.

318. Proposed by JOHN C. GREGG, Greencastle, Ind.

A thread is wound spirally n times around a cone, the radius of whose base is r, and slant height h, the turns being at uniform distance apart. If the thread is kept taut, what will be the length of the trace of its end on a horizontal plane?

No correct solution of this problem has been received. Professor Feemster has given a solution finding the length of the thread. But the problem does not require that. Let us have a number of solutions of this problem. ED. F.

319. Proposed by C. N. SCHMALL, New York City.

Given $u=\frac{yz}{x}$, $v=\frac{zx}{y}$, $w=\frac{xy}{z}$, prove

$$\begin{vmatrix} \frac{\partial u}{\partial x}, & \frac{\partial u}{\partial y}, & \frac{\partial u}{\partial z} \\ \frac{\partial v}{\partial x}, & \frac{\partial v}{\partial y}, & \frac{\partial v}{\partial z} \\ \frac{\partial w}{\partial x}, & \frac{\partial w}{\partial y}, & \frac{\partial w}{\partial z} \end{vmatrix}=4xyz.$$

Solution by S. LEFSCHETZ, Ph. D., The University of Nebraska.

If $\triangle$ is the determinant proposed, we have:

$$\triangle=\begin{vmatrix} -\frac{yz}{x^2}, & \frac{z}{x}, & \frac{y}{x} \\ \frac{z}{y}, & -\frac{xz}{y^2}, & \frac{x}{y} \\ \frac{y}{z}, & \frac{x}{z}, & -\frac{xy}{z^2} \end{vmatrix}=xyz\begin{vmatrix} -\frac{1}{x}, & \frac{1}{y}, & \frac{1}{z} \\ \frac{1}{x}, & -\frac{1}{y}, & \frac{1}{z} \\ \frac{1}{x}, & \frac{1}{y}, & -\frac{1}{z} \end{vmatrix}=xyz\begin{vmatrix} 0, & 0, & \frac{2}{z} \\ \frac{2}{x}, & 0, & 0 \\ \frac{1}{x}, & \frac{1}{y}, & -\frac{1}{z} \end{vmatrix}=4.$$

The value announced, $4xyz$, is therefore erroneous.

Solved similarly by J. Scheffer and W. J. Greenstreet.

MECHANICS.

356. Proposed by the late G. B. M. ZERR, Ph. D.

A cantilever beam length a is loaded with c pounds per running foot at its fixed end and increases uniformly to b pounds per running foot at its free end. Find the deflection at the free end due to this load.

Solution by FRANCIS RUST, E. E., Pittsburg, Pa.

The problem is solved by determining the elastic curve of the beam's axis from its second differential equation

$$y''=\frac{M}{IE},$$

as derived from Hooke's law, to be found in all text books. M is the bending moment in the point, abscissa$=x$; I is the moment of inertia of the beam's cross-section, and E is the modulus of elasticity of its material.

M is to be determined by the arrangement of the load with mathematical certainty. Taking the point, abscissa$=x$, for origin,

$$M=\int_0^{a-x} q\xi\, d\xi,$$

q, the load per lineal foot, to be expressed as a function of the variable of integration ξ. $q=c+px$, and $c+pa=b$. Consequently,

$$p=\frac{b-c}{a},$$

and q as a function of ξ is